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LGRAPHICS - Combined Graphics Package for TCA

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## INTRODUCTION

The TCA experiment data treatment depends heavily on graphical output. At the beginning the output devices were defined as a Versatec printer/plotter for hard-copy and a set of Tektronix or Hewlett-Packard Visual Display Units. The Versatec also acts as the system line-printer and provides adequate copies of listings or program output at a reasonable speed (1000 lines/minute at full 132 character width).

The original problem was that Versatec provides a complete package, the "Integrated Versaplot Software V07" (1) for using the Versatec and Tektronix provides a complete package "PLOT-10 Terminal Control System" (2) for using the T4010 VDU. Both of the packages provide the same sort of user-image but both in a somewhat clumsy way. This note describes the LGRAPHICS package which resulted from the marriage of Versaplot and PLOT-10.

#### IMPLEMENTATION-VERSAPLOT

The Versaplot package contains the several disk-operation routines and these are all kept intact. Minor modifications were made to a couple of routines, since the software techniques used were at times at best unfortunate. The "Mapped" algorithm (3) was used as it requires fewer steps. In fact it may not be optimal and tests on this point will be carried out in the fullness of time. The "vector to raster" stage (RASM) is left untouched. The routines PLOT and PLOTS are low-level routines involving data book-keeping, and were slightly modified to increase generality and were reduced in size by removing the possibilities of tailoring to our Versatec model - this facility is evidently of no use to a user with one machine, and considerable saving was made.

The Versatec is compatible with the DEC line-printer driver LPDRV when printing, but needs its own driver for graphics use. This was installed exactly as prescribed in Reference (3).

#### IMPLEMENTATION - PLOT-10

At present we are equipped with Hewlett-Packard terminals 2648A. These terminals accept all standard Tektronix terminal commands in the form of escape sequences but also possess a large number of extra

possibilities. None of these has been implemented. Instead, we have installed all the low-level parts of the PLOT-10 package, although rewriting the input/output routines. In this way, we are totally compatible with either T-4010 or HP2648A terminals.

#### HIGH LEVEL SOFTWARE PHILOSOPHY

Three approaches are available to us with device-dependent input/output. Firstly, we can make two separate packages which look alike to the user but which function differently at low-level, i.e. just modify the two packages. Secondly, we can make a package which includes all the user-oriented commands and which interfaces to the device-dependent software via secondary disk-files. Such an approach was used in the Culham GHOST graphics system. Thirdly, we can make a large single package which contains all required software to run both, either or neither of the devices. We feel that for real-time use the latter clumsy approach has advantages which outweigh its considerable size. Nonetheless, a return to the first philosophy is trivialized by linking in dummy routines for the unwanted devices, thereby considerably reducing the final program size.

Finally, all software is written in Fortran to be understandable to all comers.

## HIGH LEVEL SOFTWARE - IMPLEMENTATION

We have rejected most of the high level routines in Versaplot and PLOT-10. Exceptions are LAXIS and LTSYMB, based on the Versaplot package and modified for general use. Other routines were defined from scratch as those which the typical physics-programmer is likely to require. There does not appear to be any shortcoming after many months of operation.

A complete description of the routines and their use is given in Appendix A.

It should be noted that, due to its size, the overlaying of LGRAPHICS must be considered. To this end a list of all routines and their calls is given in Appendix B. A sample tree is shown in Appendix C, which is intended to serve as an indication, not as an optimal guide.

Finally, a small example listing of a program using all of LGRAPHICS is shown in Appendix D together with its two pages of graphical output on the Versatec plotter.

USE

The package is contained in the library DKO: {7,17} VTLIB accessible by all users. The module DKO: {7,17} SHORT should be used with the library, reducing the job size. To run only on the Terminals, include the module DKO: {7,17} TONLY; and DKO: {7,17} VONLY to run on the Versatec only.

REFERENCES

- (1) Registered Trademark of Versatec, a Xerox company.
- (2) Software Product of Tektronix Inc.
- (3) Versaplot Software Reference Manual - product of Versatec.

## APPENDIX A

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### LGRAPHICS user-routines

It is vital to understand the principle that all the commands use the following set of coordinates.

- a) The page coordinates. These are fixed, in units of one centimetre on the Versatec page, with (0,0) at the bottom left-hand corner.
- b) Paper coordinates. These again have one centimetre units but the origin is displacable by the user to any point in the page coordinates. These are useful for positioning all output.
- c) Physics coordinates. These are any coordinate system, light years or femtometres, into which (typically) graphical information is to be plotted.

The significance of these coordinates is seen during the following discussion of the routines.

\* LGUNIT (IUNIT) - The obligatory first call. IUNIT is the sum of the unit codes required, at present 1 = VDU, 2 = Versatec. Calls to LGUNIT following LGRGO are also valid, switching output devices on and off.



\* LGRGO - The obligatory second call which initialises the software requested by LGUNIT. Note that only devices activated by LGUNIT are initialised by LGRGO.

LSYNC (IND) - In order to carry out normal terminal I/O during the Task, this call is necessary prior to any write statement once the graphics are initialised by LGRGO. Its action is to clear the terminal graphics buffer. If IND = 2, in addition the terminal waits for any character to be typed before proceeding, this avoids overwriting graphical output.

LGREND - The obligatory final call without which the Versatec output is lost. It also returns the VDU to normal terminal I/O mode.

LORIG (X,Y) - This call sets the paper coordinates origin to position (X,Y) in page coordinates. Initially these are at (0,0).

LFRAME - Set a new frame of output; erases VDU, new page on Versatec.

LDATE - Writes the date of production in the bottom left-hand corner of the page.

LPOINT (X,Y,IC) - moves the "pen" to the paper coordinate point (X,Y) with "pen up", if IC = 3, "pen down" if IC = 2.

LPOS (X,Y,FACTC) - returns to the caller the current position of the pen (X,Y). FACTC is the scale factor currently used (of no present use).

LTYPE (X,Y,H, TEXT, THETA, N) - prints out the alphanumeric string TEXT (array or in quotes 'TEXT') of length N characters; beginning at paper coordinates (X,Y), of character height H(cm) and at an inclination of THETA (deg.) to the x-axis.

LNUMB (X,Y,H,VAL,THETA,N) - prints out the number VAL using N decimal places; beginning at paper coordinates (X,Y) of size H(cm) and at an angle of THETA(degrees) to the x-axis.

LAXIS (X,Y,SIZE,THETA,UMIN,DU,NEXP,TEXT,N,HN,HT) - draws an annotated axis; beginning at (X,Y) in paper coordinates, of length SIZE(cm) at an angle of THETA(degrees) to the bottom edge of the page. The axis is labelled by the TEXT alphanumeric string of N characters. The origin of the axis is marked with the physics coordinate UMIN and a spacing of DU physics units per cm. The numbers are written with  $10^{\text{NEXP}}$  (NEXP = 99 → automatic choice) and height HN(cm). The text is written with height HT(cm). If N (the text characters) is negative, all annotation is on the anticlockwise side of the axes (normally for the y-axis).

LJOIN (U,V,N,I,NUM,UMIN,DU,VMIN,DV) - The physics coordinate arrays U,V are plotted out (N points). If  $I = \emptyset$  the points are joined by a line. If  $I > \emptyset$ , the points are marked by the symbol code NUM and joined. The height of the symbols is the absolute value of  $I \times 0.1$  mm. If  $I < \emptyset$  the symbols are marked but not joined.

Note! LJOIN does not check the range of the vectors.

LOGAXE (X,Y,SIZE,THETA,UMIN,D10,TEXT,N,HN,HT) - draws an annotated logarithmic axis beginning at paper coordinates (X,Y) and of length SIZE, angle THETA (degrees) to the paper bottom edge. UMIN {A VARIABLE!} is the lowest value which is rounded down to a tic mark of which the value is returned. D10 is the length(cm) of a decade. N characters of TEXT are printed (height HT(cm) ). The numbering has a height HN(cm).

LCONV (Z,V1,V2,N,ZMIN,D10) - (for log-coordinates) converts the array V1 of N physcis coordinates into paper coordinates V2 where Z is the axis origin (paper coordinates) of value ZMIN. There are decades of length D10(cm).

LCOM - The common blocks used in LGRAPHICS are requested in LCOM which should therefore always be placed high in any overlaying structure.

Many other routines exist at a lower level. For these and full details on the routines mentioned, you are referred to the full documentation.

LGRAPHICS SUMMARY

LGUNIT (IND)

LGRGO

LSYNC (IND) (1,2 : 2 = WAIT)

LGREND

LORIG (X,Y)

LFRAME

LDATE

LPOINT (X,Y,IC) IC = 3 = UP : IC = 2 = DOWN

LPOS (X,Y,FACT)

LTYPE (X, Y, H, TEXT, THETA, N)

LNUMB (X, Y, H, VAL, THETA, N)

LAXIS (X, Y, SIZE, THETA, UMIN, DU, NEXP, TEXT, N, HN, HT)

LJOIN (U, V, N, I, NUM, UMIN, DU, VMIN, DU)

LOGAXE (X, Y, SIZE, THETA, UMIN, D10, TEXT, N, HN, HT)

LCONV (Z, V1, V2, N, ZMIN, D10)

LCOM

## APPENDIX B

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### STRUCTURE OF LGRAPHICS

<u>Name</u>	<u>Source</u>	<u>Calls</u>
ADEOUT	TEK	KAS2AM
ALFMOD	TEK	TOUTPT
ANMOD	TEK	ALFMOD, TSEND
BELL	TEK	TOUTPT, IOWAIT
BUFFPK	TEK	ADEOUT, PLTCHR
CWSEND	TEK	TOUTST
DRWABS	TEK	CWSEND, VECMOD, XYCNVT
I	VERS	
INCEPT	VERS	-
INITT	TEK	SETBUF, RESET, NEWPAG
IRAM	VERS	
KAS2AM	TEK	
LAXIS	CRPP	LTYPE, LNUMB, LPOINT
LCOM	CRPP	
LCONV	CRPP	
LDATE	CRPP	LTYPE
LFRAME	CRPP	NEWPAG, PLOT, PLOTS
LGREND	CRPP	MOVABS, ANMODE, PLOT
LGRGO	CRPP	INITT, PLOTS
LGUNIT	CRPP	
LJOIN	CRPP	LPOINT, LTYPE
LNUMB	CRPP	LTYPE
LOGAXE	CRPP	LPOINT, LTYPE, LNUMB
LORIG	CRPP	
LPOINT	CRPP	MOVABS, DRWABS, PLOT
LPOS	CRPP	SEELOC, WHERE
LSYNC	CRPP	ANMODE, BELL, TSEND
LTSYMB	CRPP	LPOINT
LTYPE	CRPP	MOVABS, LPOINT, LTSYMB
MOVABS	TEK	VECMOD, XYCNVT

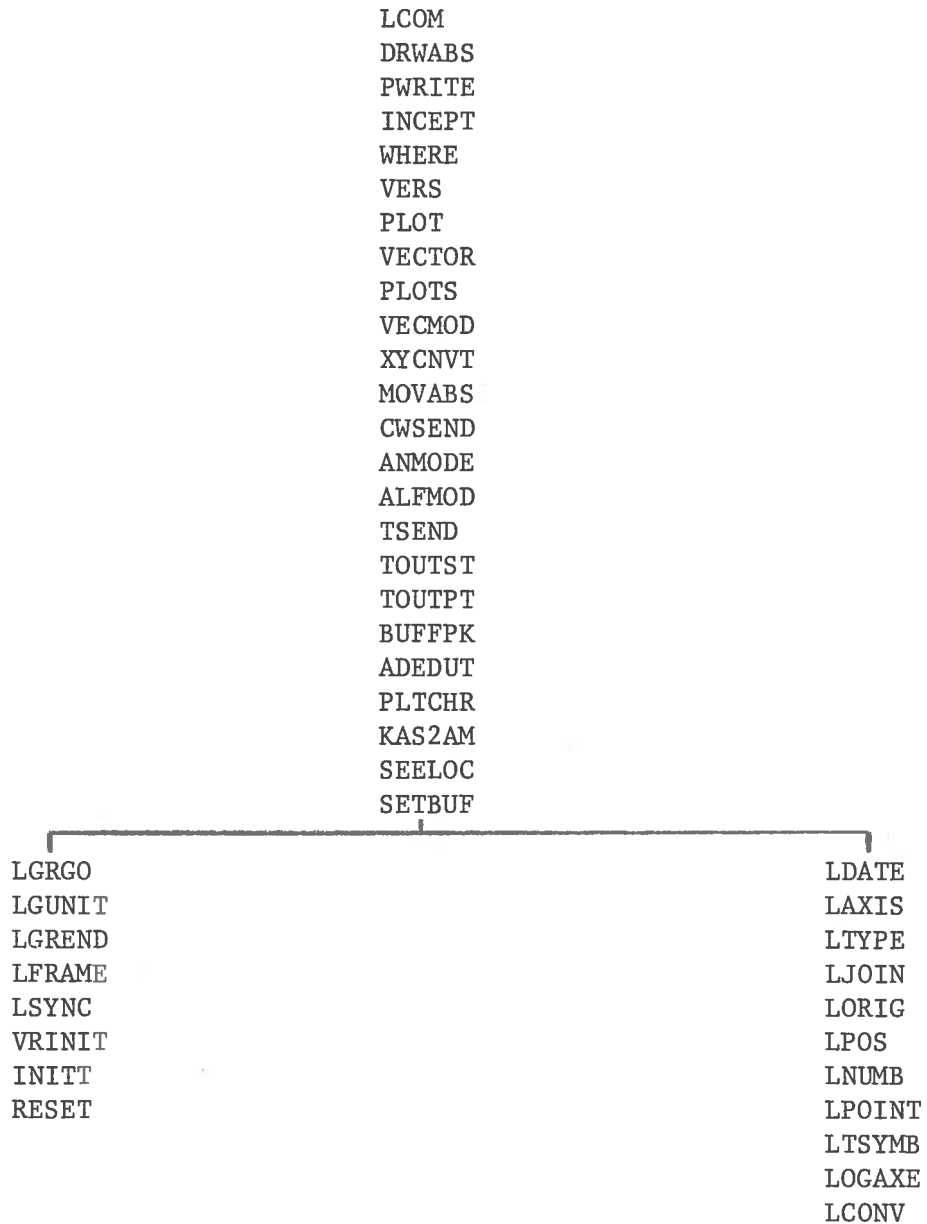
<u>Name</u>	<u>Source</u>	<u>Calls</u>
NEWPAG	TEK	ALFMOD, TOUTST, IOWAIT, MOVABS, ALFMOD
PLOT	VERS	PLOTS, VECTOR, VERS
PLOTS	VERS	VRINIT, PWRITE
PLTCHR	TEK	
PWRITE	VERS	
RESET	TEK	MOVABS, CWSEND, CHRSIZ, ALFMOD
SEELOC	TEK	
SETBUF	TEK	
TOUTPT	TEK	TOUTST
TOUTST	TEK	BUFFPK
TSEND	TEK	BUFFPK
VECMOD	TEK	TOUTPT
VECTOR	VERS	INCEPT, VERS
VERS	VERS	PWRITE
VRINIT	VERS	PWRITE
WHERE	VERS	
XYCNVT	TEK	PLTCHR, TOUTST
LDUMMY	includes	IOWAIT, CHRSIZ, A1OUT

APPENDIX C

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POSSIBLE GRAPHICS TREE

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PROGRAM LTEST
C TO TEST THE CRPP GRAPHICS
C
C AND TO PROVIDE A BENCHMARK FOR IMPROVEMENTS
C
    DIMENSION X(200),Y(200)
C
C SET PICTURE SIZE
C
    XL=21.
    ZL=13.
C
C SET UP A PARABOLA FOR PLOTTING
C
    DO 21 I=1,200
    X(I)=(I-100)
    Y(I)=X(I)*X(I) + 10.
    21 CONTINUE
C
C ASK WHETHER VERSATEC AND / OR VDU
C
    CALL GETI('ENTER UNIT',5,5,NUN)
C
C NOTE THE TIME
C
    CALL WHEN(5)
C
C INITIALISE
    CALL LGUNIT(NUN)
    CALL LGRGO
C
C PRINT THE DATE
    CALL LDATE
C
C DISPLACE THE ORIGIN
    CALL LORIG(2.0,2.0)
    DU=200./XL
    DZ=11000./ZL
    CALL LAXIS(0.,0.,XL,0.,0.,DU,99,'X-AXIS',-6,0.5,0.5)
    CALL LAXIS(0.,0.,ZL,90.,0.,DZ,3,'Y-AXIS',6,0.5,0.5)
    CALL LPOINT(0.,ZL,3)
    CALL LPOINT(XL,ZL,2)
    CALL LPOINT(XL,0.,2)
C
C PLOT A SERIES OF DISPLACED PARABOLAE
C
    DO 1 IJK=1,10
    CALL LORIG(2.0,2.0+(IJK-1)*0.2)
    CALL LJOIN(X,Y,200,0,0,-100.,DU,0.,DZ)
    1 CONTINUE
C
C NOW TITLE THE PICTURE
    CALL LORIG(0.,0.)
    CALL LTYPE(5,'ZL+3.0,0.8','V=X**2+',0.,7)
    CALL LPOS(U,Z)
    Q=10.
C
C WAIT FOR THE OPERATOR TO CONTINUE
    CALL LSYNC(2)
    CALL WHEN(5)
C
C NEW PAGE
    CALL LFRAME
C
C NEW ORIGIN
    CALL LORIG(2.,2.)
C
C SET UP FOR LOG-AXES

```



```
C PUT IN THE AXES
  CALL LAXIS(0.,0.,XL,0.,0.,DU,99,'X-AXIS',-6,0.5,0.5)
  D10=3.
  ZMIN=i.
C CONVERT THE DATA
  CALL LOGAXE(0.,0.,ZL,90.,ZMIN,D10,'LOG',3,0.5,0.5)
  CALL LCONV(0.,Y,Y,200,ZMIN,D10)
C PLOT ON LOG-AXES
  CALL LJOIN(X,Y,200,0,0,-100.,DU,0.,1.)
C PLOT A SYMBOL , WHY NOT ?
  CALL LTYPE(10.,10.,3.8,14,0.,-1)
C WAIT FOR OPERATOR
  CALL LSYNC(2)
C NOTE TIME
  CALL WHEN(5)
C FINISH UP
  CALL LGREND
C NOT THE FINISH TIME
  CALL WHEN(5)
  STOP 'LTEST'
  END
```

$$Y = X \times \times 2 + 10.0$$

